An AIChE Technology Alliance

CCPS

Center for Chemical Process Safety

Learning from QRA for pipelines – A case study approach

22nd September 2014

8th CCPS Asia Pacific Regional meeting on process safety

Chola MS

RISK SERVICES

Overview

- Introduction
- Scope & Objective
- QRA methodology
- Sensitivity analysis
- Observations
- Mitigation Measures
- Learning
- Areas requiring Attention

Introduction

- Pipelines are a safe and efficient means of transporting large quantities of crude oil
  - Require significantly less energy to operate
  - A much lower carbon footprint

Pipeline Incidents

June 27th India (Andhra Pradesh) : Natural Gas pipeline explosion

July 31stTaiwan: propylene pipeline explosion

Case study

Introduction: The case studied is for a Pipeline Corridor-Gravity lines

- 3.85 Km long crude oil pipeline from tank farm to refinery pump house is considered for the study.
- Risk associated with the pipeline is estimated
- Sensitivity analysis is carried out to understand the criticality by varying inventory, failure frequency and population. Trends are observed.

Scope & Objective

- The objective of the study is to use Sensitivity Analysis to help identify mitigation measures which can have major impact on risk reduction.
- To share the learning which at times goes beyond the technical aspects

Pipeline Layout

Chola MS
RISK SERVICES

QRA methodology

- Determines the potential for damage or injury from specific incidents.
- A single release (e.g. Leak of gasoline pipeline) could result in different possible outcomes e. g
  - Jet fire
  - Pool fire
  - Flash Fire
  - Toxic dispersion

Consequence analysis

Failure frequency calculation

Risk estimation

Risk presentation

ALARP demonstration

QRA methodology

Jet Fire

Leak size(mm)	Jet fire: Distance to radiation levels (m)					
	1.5F Weather condition			5D Weather condition		
	6.0 Kw/m2	12.5 Kw/m2	37.5 Kw/m2	6.0 Kw/m2	12.5 Kw/m2	37.5 Kw/m2
70	78.9	52.9	13.1	74.3	53.3	34.1
FBR	330.7	239.0	112.3	264.6	193.7	124.6

Consequence analysis

- Failure frequency calculation
- Risk estimation
- Risk presentation
- ALARP demonstration

QRA methodology

Pool fire:

Leak size(mm)	Pool fire: Distance to radiation levels (m)					
	1.5F Weather condition			5D Weather condition		
	6.0 Kw/m2	12.5 Kw/m2	37.5 Kw/m2	6.0 Kw/m2	12.5 Kw/m2	37.5 Kw/m2
70	423.3	306.2	176.7	403.4	301.8	196.2
FBR	708.4	514.8	304.0	715.7	534.8	347.7

Consequence analysis

- Failure frequency calculation
- Risk estimation
- Risk presentation
- ALARP demonstration

QRA methodology

Parts count	
Type	Diameter(in)
Pipeline	36
Flange	36
Actuated valves	36
Instrument connections	2

Release Diameter (mm)	Failure frequency
70	5.14E-05
>150	5.18E-05

Ref: OGP – Risk assessment data directory, March 2010

Consequence analysis

Failure frequency calculation

Risk estimation

Risk presentation

ALARP demonstration

QRA methodology

- This combines the consequences and likelihood of all incident outcomes from all selected incidents to provide a measure of risk.

Risk = Likelihood * Severity

•Risk depends on:

- ➢Consequence,
- ➢Base event frequency
- ➢Ignition probability
- ➢Population density in the area
- ➢Weather conditions etc.

Consequence analysis

Failure frequency calculation

Risk estimation

Risk presentation

ALARP demonstration

QRA methodology

- Individual risk
- Societal risk

Risk associated with pipeline (per average year)	
Individual Risk Per Annum	4.64E-03
Societal Risk	1.78E-03

Sensitivity analysis

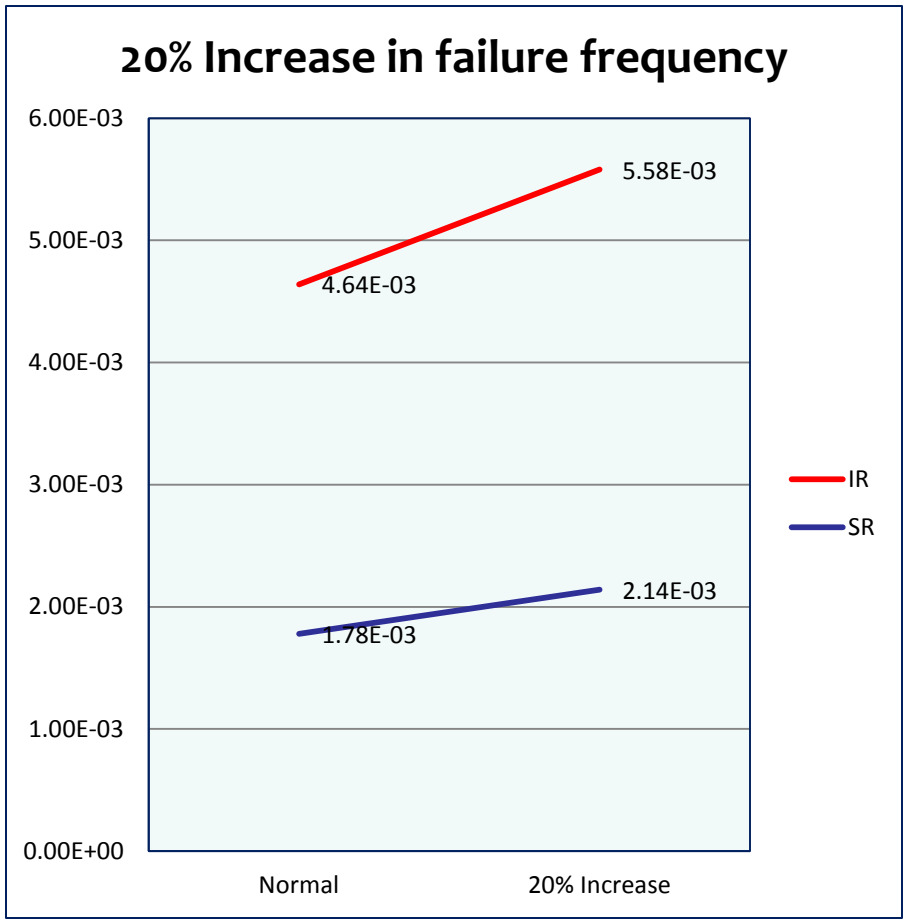
Case – 1 : Increase / decrease in Failure Frequency

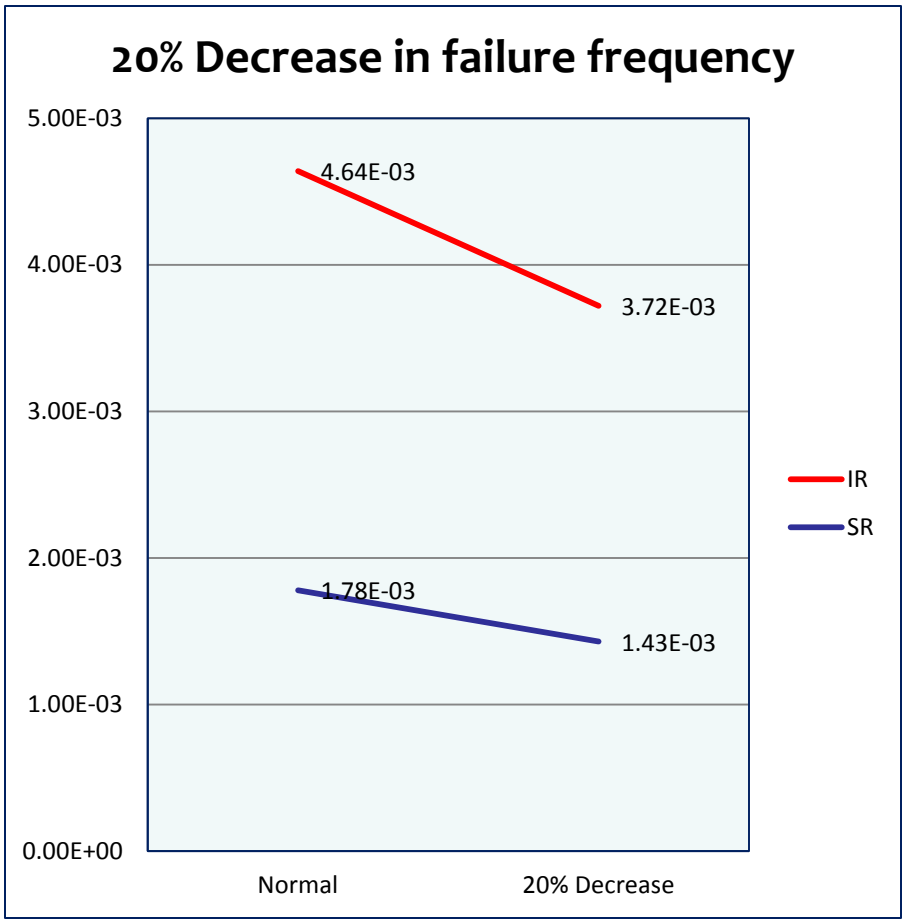
- Considering the excavation, nature of pipeline, properties of chemical flowing (corrosive nature) from the pipeline, failure frequency may vary.

Risk	20% Increase in FF	20% Decrease in FF
Individual Risk Per Annum	5.58E-03	3.72E-03
Societal Risk	2.14E-03	1.43E-03

Note: All units are in " per Average Year"

Sensitivity analysis





Inference: Risk values directly varies with failure frequency.

Chola MS RISK SERVICES

Sensitivity analysis

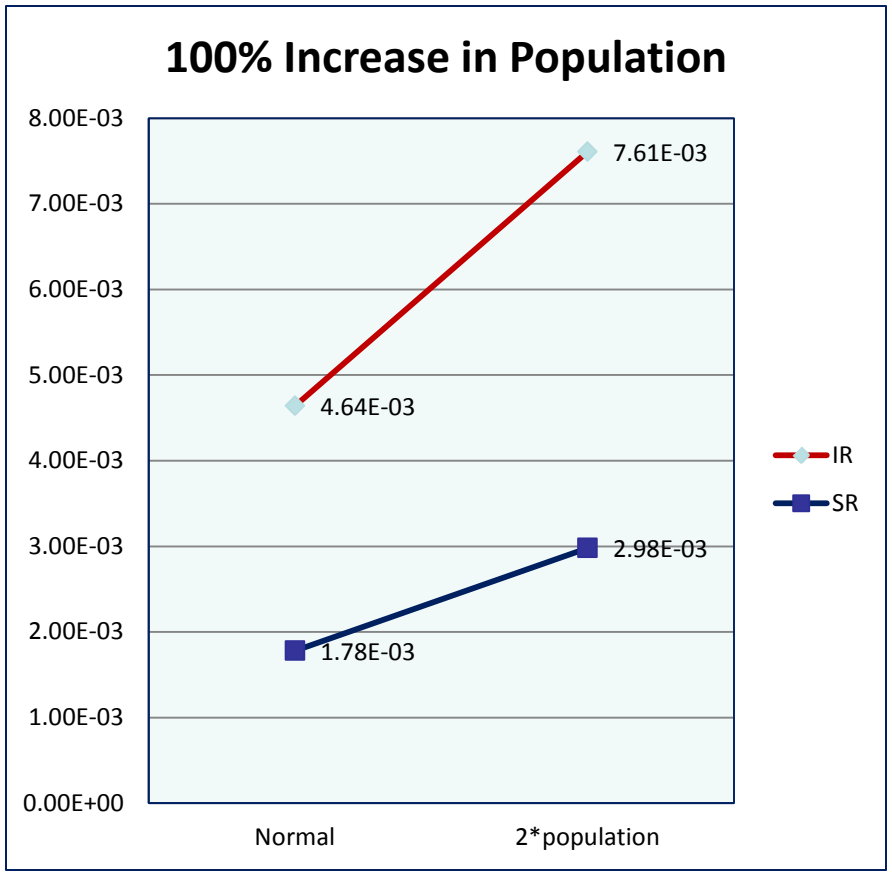
Case – 2 : Increase / decrease of Population

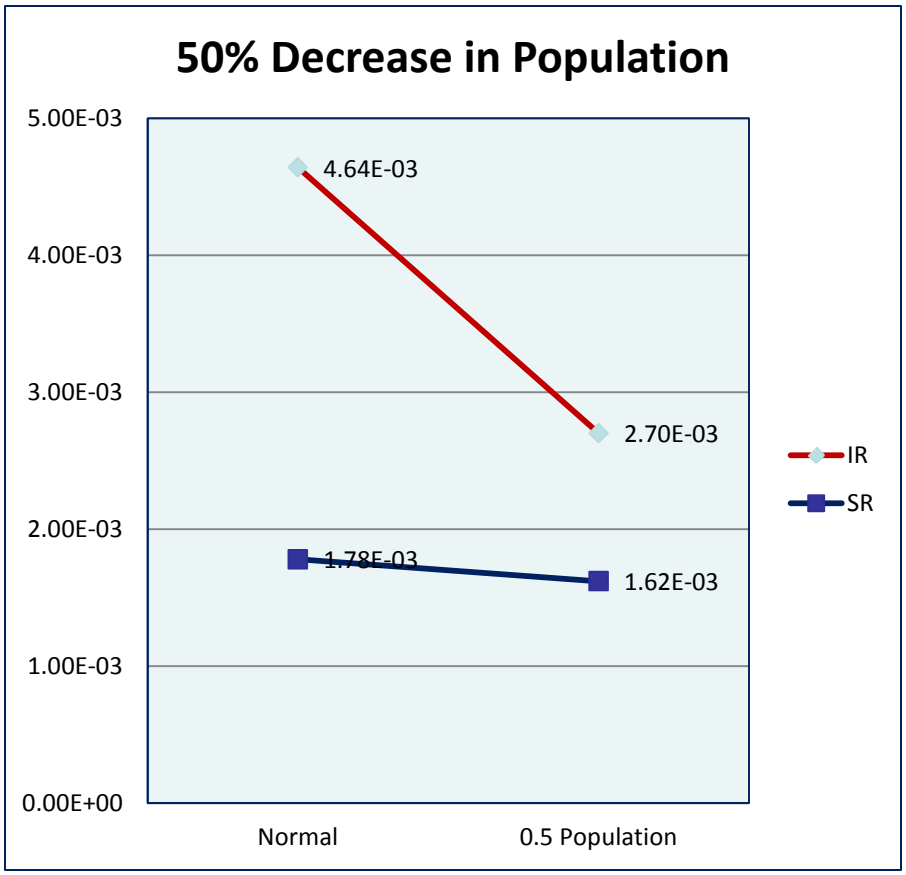
- Considering the renovation of the society in the vicinity of the pipeline or limit the people in the vicinity of pipeline Risk will differs.

Risk	100% Increase Population	50% Decrease in Population
Individual Risk Per Annum	7.61E-03	2.70E-03
Societal Risk	2.98E-03	1.62E-03

Note: All units are in " per Average Year"

Sensitivity analysis





Inference: Risk values directly varies with Population

Observations

- Risk increase or decrease is directly proportional to Failure Frequency.
- Same is true for Population.
- Hence, ‘Rate of Change’ or slope of this line shall suggest which parameter shall play a major role in risk reduction
- Consequence shall change based on other factors such as release inventory, wind speed , easy availability of source of ignition etc.
- Hence, mitigation measures which bring reduction in inventory shall impact the risk in a major way.

Mitigation Measures

- Target should be to choose a mitigation measure that will have maximum impact on the risk.
- Bund Wall along the pipeline in critical sections with sump / catch pit in safe areas which can contain the major leak.
- Evaluation of addition of Sectionalising valves interlocked with Leak Detection system can help in quick isolation and reduction in leaked quantity.
- Other soft measures such as High Security Fencing, Access Control helping in reducing failure frequency due to third party damage or Corrosion Monitoring and control or reducing population in designated areas.

Learning

- Considering the operation, Interlocking leak/fire detection system with isolation valves as generally thought to be effective was not recommended. As per operations group, they close the upstream valve only, allowing the liquid to flow to Pump house which brings in the desired reduction in released inventory.
- Require special focus on mitigation measures in Populated areas / Road crossings etc.

Areas requiring Attention

- Mutual Risk Management --
  - Additional Risk due to upcoming process facilities of other service providers
  - Increasing risk due to population increase and compromise on safe distance from risk source
- Solution –
  - Regulations / Guidelines to include 'Mutual Risk' aspect?
  - Stricter monitoring of Violations – encroachments?

Cholamandalam MS Risk Services Limited

(An ISO 9001:2008 Certified Company)

"Parry House" 4th Floor, No. 2, N.S.C. Bose Road, Chennai - 600 001, India

Call : + 91 44 3044 5620-30 / Fax +91 44 3044 5550 /

E-mail inquiry@cholams.murugappa.com or visit www.cholarisk.com

Chola MS RISK SERVICES

ISO 9001 QUALITY MANAGEMENT SYSTEM BSI